Graded Interference Filter Spectrometer

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Problem Statement

Volatile organic compounds (VOCs) used in many manufacturing industries can have negative impacts on the environment and also pose significant health and safety concerns:

⇨Many VOCs are considered precursors to ground-level ozone, a primary component of smog. Ozone can cause respiratory problems in humans and can also have adverse effects on plants and ecosystems.

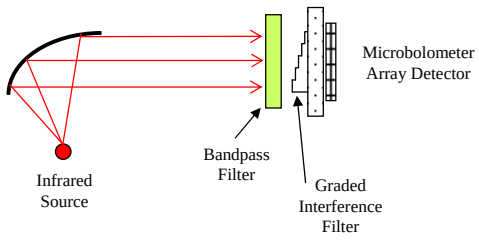
⇨Many VOCs are carcinogenic.

⇨Many VOCs pose explosion hazards.

There is a strong need for a low-cost, compact sensor that can quickly and reliably identify leaks in industrial process lines. While infrared spectroscopy is recognized as a powerful and versatile technique for compositional chemical analysis, conventional infrared spectrometers are expensive, complex and physically bulky.

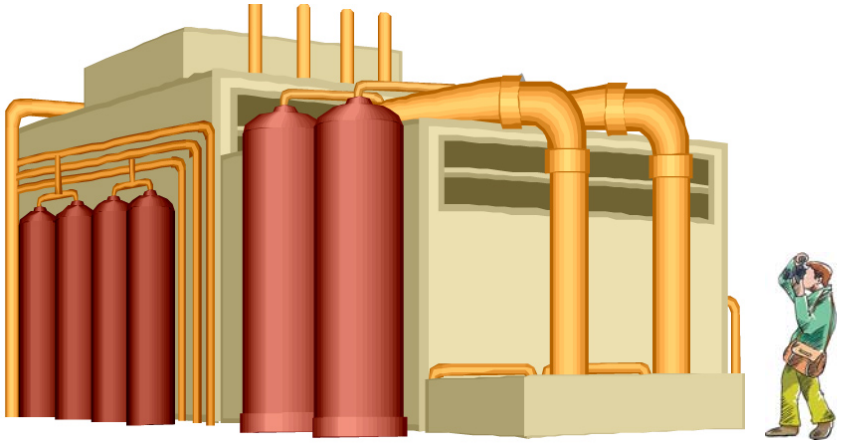
Technology Description

This program will develop an infrared spectrometer-based sensor for remote detection of VOCs. The basic design of the spectrometer involves the coupling of an array of Fabry-Perot etalons with an IR microbolometer focal plane array (FPA) detector. The etalon array or *graded interference filter* consists of an array of optical coatings with thicknesses graded in a discrete manner. Each element of the array is optically aligned with a pixel (or group of pixels) in the FPA. The array of etalons is used to modulate the incident spectrum with a wavelength-periodic transmission function defined by the fringe pattern of each etalon. Using a sufficient number of etalons, each with its own detector, the measurements from the etalon array provide an interferogram which can be mathematically transformed to recover the original spectrum. The spectrometer can be configured with an integral IR source, as illustrated in the figure below, or for remote sensing using appropriate optics.



Expected Results

Phase I will demonstrate a prototype infrared spectrometer based on a vacuum-deposited filter array coupled with an infrared camera. Phases II and III will result in a portable, low-cost and rugged sensor to be used in industrial environments for rapid detection and identification of VOCs, as shown in the figure below.



Application of the technology as a remote, hand-held chemical vapor leak detector.

Potential Environmental Benefits

The sensor to be developed in this program will enable rapid detection of VOCs, signifying the need for corrective action and thereby reducing human and environmental exposure to ground-level ozone and carcinogenic and/or explosive vapors.

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